

Final

Supplemental Field Investigation Plan
Landfill C and Landfill D
St. Juliens Creek Annex Site
Chesapeake, Virginia



Prepared for

Department of the Navy
Atlantic Division
Naval Facilities Engineering Command
Norfolk, Virginia

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Prepared by

CH2MHILL

Baker

Environmental, Inc.

CDM

Federal Programs Corp.

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Landfill C (Site 3) and Landfill D (Site 4)**

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Chesapeake, Virginia**

Contract Task Order 0027

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Under the

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ABBREVIATIONS AND ACRONYMS

BERA	Baseline Ecological Risk Assessment
bgs	below ground surface
BTAG.....	Biological Technical Assistance Group
COPC	chemical of potential concern
CTO	Contract Task Order
DPT	direct push technology
EPA.....	United States Environmental Protection Agency
FS	feasibility study
HHRA	Human Health Risk Assessment
PCB.....	polychlorinated biphenyl
PVC	polyvinyl chloride
RFA.....	RCRA Facility Assessment
RI.....	remedial investigation
SVOC.....	semivolatile organic compounds
TAL.....	target analyte list
TCE.....	trichloroethene
TCL.....	target compound list
TOC	total organic carbon
VDEQ.....	Virginia Department of Environmental Quality
VOC.....	volatile organic compounds

1. Background

CDM Federal has been conducting remedial investigation/feasibility studies (RI/FS) at four sites at St. Juliens Creek Annex for the Navy. The work is being conducted under two contact task orders (CTOs), each with two sites. CTO 027 includes Landfill C and Landfill D, and CTO 028 includes Landfill B and the Burning Grounds. In February 1998, CDM Federal submitted draft remedial investigation reports for all the sites. The reports included the results of the remedial investigation and the Human Health Risk Assessments (HHRA). Baseline Ecological Risk Assessments (BERAs) are also being prepared and will be submitted as separate documents.

During the preparation of the draft RI reports and BERAs, as well as during discussions with the Biological Technical Assistance Group (BTAG), Environmental Protection Agency Region III (EPA), and Virginia Department of Environmental Quality (VDEQ), it became apparent that additional data were necessary to fully define the extent of contamination. At the request of the Navy, CDM Federal prepared this Supplemental Field Investigation Plan to acquire the additional data.

The purpose of this Supplemental Field Investigation Plan is to present the data needs that have been identified to date for Landfill C and Landfill D. Data needs for both sites are discussed in this plan. The "Final Landfill C and Landfill D Work Plan", dated May 1997, should be referenced for pertinent information regarding this Supplemental Site Investigation Plan. The data needs identified for the sites investigated under CTO 28 are addressed in a separate document. This plan does not address the background investigation, which may be conducted at the same time as this supplemental investigation.

Landfill C

Landfill C (Site 3) covers 10 acres along the northern edge of the Annex and is accessible by way of a patrol road (Figure 3-1). The area was originally a mudflat where refuse was dumped and allowed to burn; the ash was then used to fill in the area. The landfill is unlined. Operation began in 1940 and continued until 1970. The landfill was graded level and covered with grass, but it has not been formally closed.

Refuse disposed of at Landfill C included solvents, acids, bases, and mixed municipal waste. The total volume of trichloroethene (TCE), waste oil, and oil sludge's was estimated to be 750,000 cubic feet prior to burning. Two pits reportedly used for disposal of oils and oily sludge's, as well as for periodic burning were also located at the Landfill C site. No other information is known about the sludge pits.

Landfill D

Landfill D (Site 4) covers an estimated 5 acres approximately 300 feet south of Site 3 (Figure 3-2). Site 4 was an unlined trench and fill landfill that reportedly operated from 1970 to 1981. The first trench was approximately 1,000 feet long and was located parallel to and 500 feet north of Blows Creek. Soils from subsequent trenches were used to cover previous trenches. The total number of trenches dug in the landfill is not known.

Refuse disposed of at Site 4 included drums of unknown wastes and polychlorinated biphenyls (PCBs). According to personnel at the public works department, the PCBs probably came from ballast containers for fluorescent light fixtures. The RCRA Facility Assessment (RFA) indicated that several tanks with undetermined wastes were also once located in the area. Total volumes of disposal are unknown.

2. Supplemental Field Investigation Objectives

The objectives of the supplemental field investigation include:

- 1) Collect sufficient data to define the extent of contamination at the two sites;
- 2) Collect samples that could not be collected during the original field investigation;
- 3) Collect sufficient samples for the completion of HHRA and BERA; and,
- 4) Collect samples and data required for completion of the FS.

3. Methods and Scope

The scope of the investigation at each site is described in detail in the following subsections. Each section includes a sample location map which shows the locations of previous work (samples and wells) as well as the proposed location of additional samples.

Each section also includes a table of samples and analyses. Analytical methods will be the same as those used in the previous remedial investigation (CDM Federal 1997) and are not referenced on these tables unless the analysis has not been previously performed.

The Health and Safety plan developed for the previous RI will be used for the supplemental investigation or modified as necessary to include activities that were not previously conducted. The frequency of quality assurance/quality control samples will be the same during this investigation as during the previous investigation.

3.1 Sample Collection Methods

Generally, sample collection and monitoring well construction methods will be the same as those listed in the RI Work Plan (CDM Federal, 1997). Two exceptions to this are subsurface soil samples and sediment samples. Additional/alternative methods that may be used during the supplemental investigation are described in the following subsections.

3.1.1 Subsurface Soil Samples

During the RI, direct push technology (DPT) was used to collect subsurface soil samples. This method involves the use of a truck-mounted rig, however, some of the proposed sampling locations in this Supplemental Field Investigation Plan are in areas with difficult access. These include areas of heavy brush and areas that are potentially wet, or where near surface soils are saturated. In order to avoid unnecessary destruction of potential wetlands, or time-consuming brush clearing operations, a stainless steel hand auger will be used to collect subsurface soils in these areas. A truck mounted DPT rig will be used in all other locations. Boreholes resulting from subsurface soil sampling activities will be sealed with hydrated bentonite powder or pellets.

3.1.2 Sediment Sampling

Some of the sediment samples proposed for the supplemental investigation are located in areas with greater than 6 inches of standing water. Those samples will be collected with a stainless steel petite ("mini") ponar dredge or equivalent.

3.2 Decontamination Procedures

Decontamination methods will be the same as those listed in the RI Work Plan (CDM Federal, 1997). The hand auger and ponar dredge will be decontaminated in the same manner as other stainless steel sampling equipment (bowls and spoons).

3.3 Site 3 Landfill C Investigation

During preparation of the RI, BERA, and HHRA, some data gaps were identified for Landfill C. Additionally, the data were reviewed by the project engineer to identify additional needs for the Feasibility Study. The preliminary findings of the remedial investigation at Landfill C are shown on Table 3-1.

The proposed supplemental work and rationale for the work at the site is described below. The locations of the proposed additional sampling at the site are shown in Figure 3-1. (See Section 1.0 for summary of Landfill C historical usage.)

3.3.1 Disposal Area Exploration

During the RI a geophysical investigation of the site was conducted in order delineate the landfill boundaries. No anomalies that can be associated with landfilling activities were identified. In addition, no waste materials (ash or sludges) were encountered in the soil borings. The chemicals of potential concern (COPCs) identified for site surface soils are consistent with those that would be expected in hydraulic dredge material (metals, semivolatile organic compounds [SVOCs]), so the source of the COPCs in surface soil can not be determined based on the available data.

In order to locate the landfill, in particular the pits that were reportedly used for sludge disposal, a series of DPT borings will be drilled along four lines located perpendicular to the road that crosses the middle of the site. Approximately 10 borings will be drilled along each line at a spacing of approximately 5 feet. The borings will not extend into groundwater. A geologist will log each boring to identify layers of fill, ash or waste. The standard operating procedure for DPT sample collection is presented in Attachment 1.

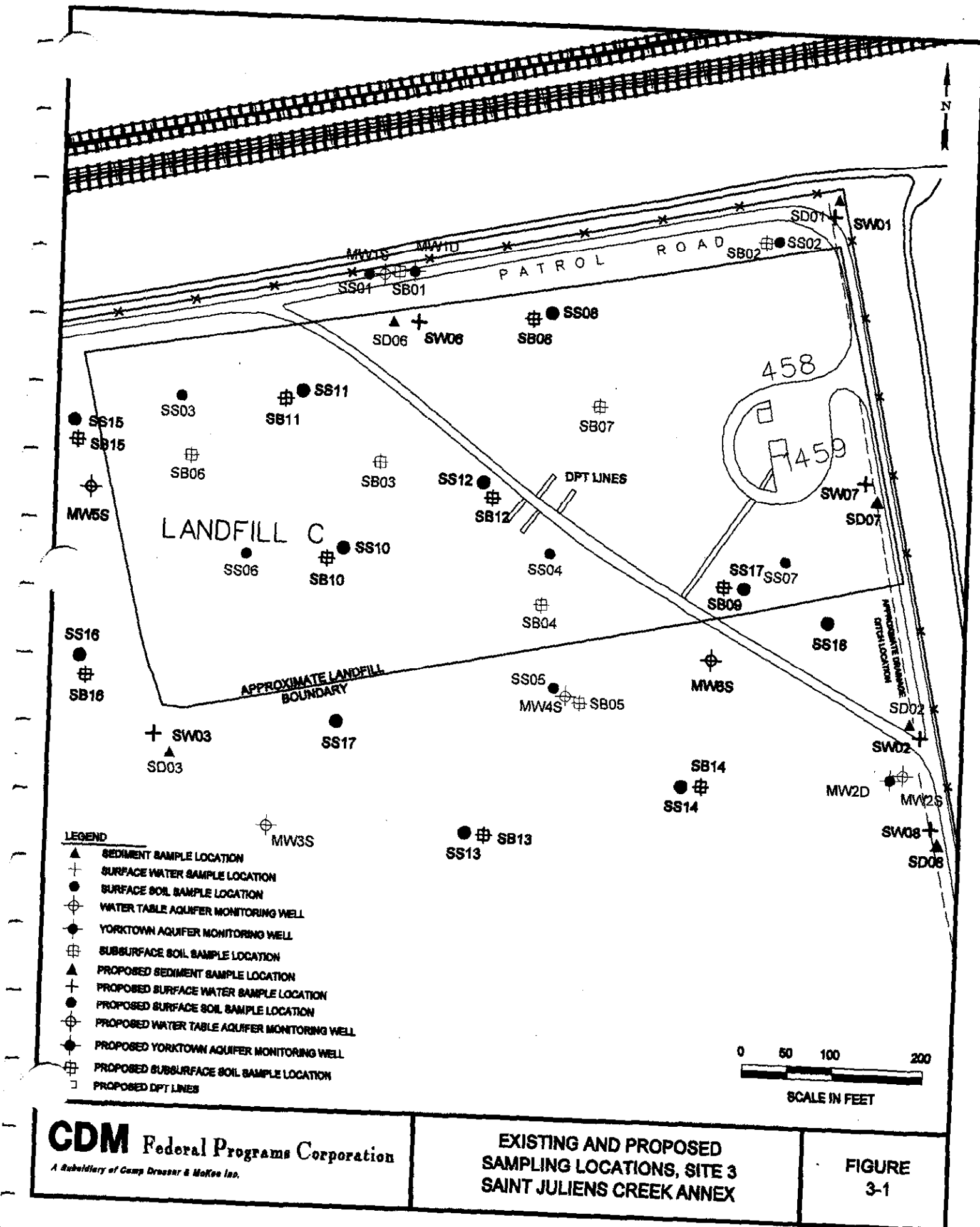
The samples will be collected using a direct push technology rig and a 4-ft long Macro Core sampling device or equivalent. The core samples will be examined for visible indications of waste material.

If there is no visual evidence of waste material, a composite sample of the soil core will be placed in a jar (until the jar is approximately half full) for headspace analysis. The headspace jar will be sealed with aluminum foil and the lid will be placed on the jar. A separate sample for volatile organic compounds (VOCs) analysis will then be collected and immediately placed on ice.

The remaining soil will be composited with a stainless steel bowl and spoon. The soil will be placed in the appropriate containers for: 1) hydrocarbon analysis utilizing a field test kit (the Dexsil® PetroFLAG® Test System), and 2) the remaining target compound

TABLE 3-1
LANDFILL C PRELIMINARY RESULTS

MEDIA / ACTIVITY	OBJECTIVE	OPERATIONS	ANALYTE GROUP	PRELIMINARY RESULTS
Geophysical Survey	Determine the boundaries of the landfill	Conducted EM31 survey on a 100' grid.	Not Applicable	No anomalies indicative of landfill activity were identified.
Surface Soil	Identify type and extent of surface soil contamination	Collected 7 surface soil samples (0 to 0.25 ft)	TCL/TAL metals Total phosphorus	COPCs include metals, PCBs, pesticides, and SVOCs. Extent of COPCs not defined to the south, east and west. Ambiguity exists concerning the source of the COPCs due to the fact that the sampled material is dredge spoils from the south branch of the Elizabeth River. In addition, the concentration of naturally occurring metals is not known.
Subsurface Soil	Identify waste disposal areas, as well as nature and extent of contamination	Collected 7 subsurface soil samples from various depths between 2 and 5 ft. One composite sample for BERA collected 0 to 3 ft.	TCL/TAL metals Total phosphorus	COPCs include metals, one VOC and SVOCs. Minor VOCs (low levels of methylene chloride and toluene) were detected in one subsurface sample. Several PAHs in most of the samples. Ambiguity exists concerning the source of the PAHs because the sampled material is dredge spoils from the south branch of the Elizabeth River. Insufficient samples collected for BERA.
Groundwater	Determine direction of groundwater flow. Identify nature and extent of groundwater contamination.	Installed 2 Yorktown Aquifer monitoring wells and 4 shallow monitoring wells. Collected two rounds of samples.	TCL/TAL metals (filtered and unfiltered) Total phosphorus	COPCs include chloroform (deep aquifer only), one SVOC (shallow aquifer only) and metals. Two of the shallow monitoring wells were screened in a perched water table. Direction of groundwater flow has not been determined. Background concentrations of metals have not been established.
Surface Water	Determine nature and extent of contamination in surface water.	Due to dry weather conditions, no surface water was available.	None	The nature and extent of contamination in surface water at the site has not been determined.
Sediment	Determine nature and extent of contamination in sediment.	Collected four sediment samples.	TCL/TAL metals Total Phosphorus Total Organic Carbon (TOC)	COPCs include pesticides, PCBs, one SVOC and metals. Although background concentrations of metals in sediments has not been determined, one sample collected from a drainage ditch (SD02) contained anomalously high concentrations of chromium, copper, lead and zinc. Extent along the ditch (upstream and downstream) has not been determined.



list (TCL)/target analyte list (TAL) analyses. These samples will be immediately placed on ice.

After the headspace samples have warmed to room temperature, the lid will be removed and the probe of a photoionization detector inserted through the aluminum foil. A reading of the vapors present in the "headspace" of the jar will be made. If more than one sample has been collected from a single boring location, the sample with the highest headspace reading will be analyzed for hydrocarbon using the field test kit.

Four samples collected during the disposal area investigation will be sent to the off-site laboratory for full TCL/TAL analysis. In selecting the four samples for off site laboratory analysis, samples with visual contamination (sludges, ash, discolored soil or oily substances) will be selected first and samples of soil with the highest measurement of hydrocarbons in the field analysis will be selected second. If additional samples are required in order to submit four samples, soil with elevated headspace readings (above ambient) will be sent.

3.3.2 Subsurface Soil

In addition to the subsurface soil samples collected during the disposal area investigation, nine subsurface soil samples will be collected for the identification/delineation of the landfill in other locations across the site (see Figure 3-1). All borings will be performed with a DPT rig and a 4-ft long Macro Core sampling device or equivalent (See DPT SOP, Attachment 1). The borings will extend to the water table, typically 3 to 5 ft below ground surface (bgs) at the site. If field evidence (e.g., screening readings above ambient on a photoionization detector) indicates possible contamination, or if layers of waste are identified, a sample will be collected from that material. If there is no visual or other field evidence of waste material, a sample will be collected from a depth interval from 2 feet above the water table to the water table.

3.3.3 Surface Soil

A surface soil sample will be collected at each of the nine subsurface soil sample locations in order to provide additional data for the BERA as well as the HHRA. Two additional surface soil samples will be collected south of the suspected landfill boundary as shown on Figure 3-1, to determine the southern extent of surface soil contamination. Surface soil samples will be collected from depths of 0.0-6.0 inches bgs. . Soil samples will be analyzed for TPH, by Method 8015M to identify oily sludges reported to be disposed at the Landfill.

3.3.4 Groundwater

Analysis of the RI data indicates that two of the four shallow monitoring wells that were installed during the RI are screened in a perched water table. Therefore the direction of groundwater flow in the water table aquifer has not been determined at Landfill C. During the supplemental investigation, two additional monitoring wells, screened in the water table aquifer, will be installed in order to determine the direction of groundwater flow in that aquifer. These additional wells will be located downgradient of areas suspected of being in the landfill:

Monitoring well MW05S: Located in the water table aquifer, west of SB03 and SB06 where solvents were detected.

Monitoring well MW06S: Located in the water table aquifer southeast of SB03 and SB06.

The locations of the monitoring wells may be subject to change based on the visual observations of the DPT and subsurface soil sampling.

All newly installed monitoring wells will be given a minimum of 24 hours between well construction and well development.

All monitoring wells at the site will be sampled during the groundwater sampling event.

3.3.5 Surface Water and Sediment

3.3.5.1 Surface Water

At Landfill C, surface water samples could not be collected during the original field effort due to dry weather conditions. Therefore these surface water samples will be collected during the supplemental field investigation if surface water is present. Additionally, surface water samples will be collected at the two new sediment sample locations described in Section 3.3.5.2.

Analysis of the surface water for salinity will be included for the ecological risk assessment. The salinity will be measured with a field instrument such as a Horiba U-10 Water Quality Meter or equivalent.

3.3.5.2 Sediment

During previous RI activities at Landfill C, sediment sample SD02 (located in a drainage ditch on the east side of the study area) contained elevated levels of metals. In order to determine the extent of contamination in the ditch, two additional sediment samples will be collected from the ditch, one located approximately 350 ft north of SD02 and one located approximately 200 ft south of SD02.

3.3.6 Sample Analyses

The proposed sampling and analysis strategy for Landfill C is summarized in Table 3-2.

3.4 Site 4 Landfill D Investigation

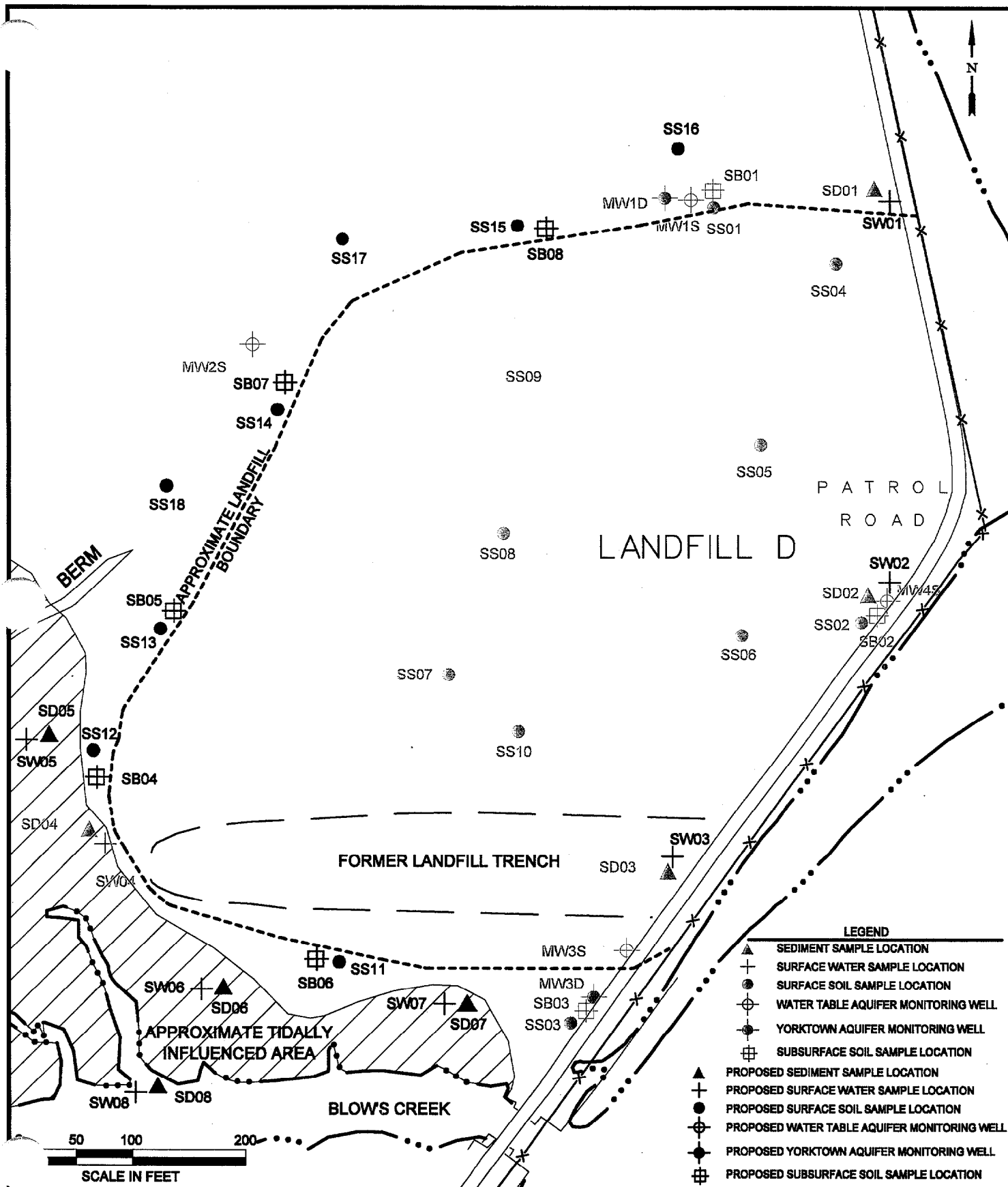
The preliminary findings of the Remedial Investigation at Landfill D are shown on Table 3-3. The proposed supplemental work and rationale for the work at the site is described below. The locations of the proposed samples are shown on Figure 3-2. (See Section 1.0 for summary of Landfill D historical usage.)

TABLE 3-2
LANDFILL C PROPOSED SAMPLING AND ANALYSIS STRATEGY

MEDIA/ ACTIVITY	OBJECTIVE	NUMBER OF SAMPLES	ANALYTE GROUP	SAMPLE AND ANALYSIS RATIONALE
Surface soil	Provide additional data for the HHRA and BERA. Define extent of surface soil contamination.	11	TCL/TAL metals TPH	Samples are located to the southeast and west of the area where VOCs were detected in subsurface soil. Will analyze for TPH, by Method 8015M, to identify oily sludges reported to be disposed at the Landfill.
Subsurface Soil	Identify waste disposal areas.	13	TCL/TAL metals Field screening of DPT samples with Immunoassay field test kit for TPH.	Will use DPT to explore subsurface along four lines perpendicular from the road that crosses the site. Disturbed soil in the area is shown on historical aerial photographs. Will screen with field tests and select 4 samples for full analyses.
Groundwater	Determine direction of groundwater flow. Identify nature and extent of groundwater contamination.	8	TCL/TAL metals (filtered and unfiltered) Low level VOC Total phosphorus	Two new shallow wells will be screened in the shallow aquifer to determine groundwater flow direction. Location selected is expected to be downgradient of area where VOCs were detected in subsurface soil. All wells will be sampled.
Surface Water	Determine nature and extent of contamination in surface water.	6	TCL/TAL metals (unfiltered) Low level VOC Total phosphorus Salinity (field measurement)	No previous samples have been collected due to dry conditions. Locations selected in low areas and drainage features. Paired with sediment sampling locations.
Sediment	Refine extent of contamination.	2	TCL/TAL metals Total phosphorus TOC	Elevated levels of metals detected in sample from drainage ditch. Proposed samples will be located upstream and downstream of that sample to more accurately define the extent of contamination.

TABLE 3-3
LANDFILL D PRELIMINARY RESULTS

MEDIA/ ACTIVITY	OBJECTIVE	OPERATIONS	ANALYTE GROUP	PRELIMINARY RESULTS
Geophysical Survey	Determine the boundaries of the landfill. Confirm/Deny presence of buried drums.	Conducted EM31 and cesium magnetometer survey on a 100' grid, where possible, and along several transects. Conducted a limited GPR survey.	Not Applicable	Anomalies indicative of landfill activity were identified and the boundaries were determined. No definitive reflectors indicative of buried drums could be identified using GPR. Many reflectors were noted, however these should be pieces of concrete, large metal objects or other items.
Surface Soil	Identify type and extent of surface soil contamination	Collected 10 surface soil samples (0 to 0.25 ft). Nine samples from the top surface of the landfill.	TCL/TAL metals Total phosphorus	COPCs include metals, PCBs, pesticides, VOCs and SVOCs. Extent of COPCs not defined to the south, north, east and west. Ambiguity exists concerning the source of the PAHs in the northernmost sample (SS01) due to the fact that the sampled material is dredge spoils from the south branch of the Elizabeth River. In addition, the concentration of naturally occurring metals is not known.
Subsurface Soil	Identify lateral extent, nature and depth of waste.	Collected 3 subsurface soil samples from various depths between 2 and 5 ft. from areas adjacent to the landfill boundaries. One composite from 0 to 3 ft collected for BERA.	TCL/TAL metals Total phosphorus	COPCs include metals, and one SVOC. Due to the presence of buried concrete, and large metal items in the landfill, drilling and sampling through the landfill were not possible. Insufficient data collected for BERA. Background concentration of metals has not been determined.
Groundwater	Determine direction of groundwater flow. Identify nature and extent of groundwater contamination.	Installed 2 Yorktown Aquifer monitoring wells and 4 shallow monitoring wells. Collected two rounds of samples.	TCL/TAL metals (filtered and unfiltered) Total phosphorus	COPCs include chloroform (deep aquifer only), and metals. Direction of groundwater flow has been determined. Background concentrations of metals have not been established.
Surface Water	Determine nature and extent of contamination in surface water.	Due to dry weather conditions, only one surface water sample (from Blows Creek) was collected.	TCL/TAL metals Total Phosphorus	COPCs include acetone, 4-methylphenol, total phosphorous, and metals. The nature and extent of contamination in surface water at the site has not been determined.
Sediment	Determine nature and extent of contamination in sediment.	Collected 4 sediment samples.	TCL/TAL metals Total Phosphorus TOC	COPCs include metals, pesticides, PCBs, SVOCs, and VOCs. Extent of sediment contamination attributable to Landfill D in Blows Creek has not been determined. Background concentrations of metals have not been determined.



3.4.1 Subsurface Soil

Five subsurface soil samples will be collected from locations around the perimeter of the landfill for landfill delineation. Borings will be performed with a DPT rig and a 4-ft long Macro Core sampling device or equivalent, or a stainless steel hand auger. The hand auger will be used at those locations not easily accessible with a DPT rig. The borings will extend to the water table or 5 ft, whichever is deeper. Although the water table is typically found at depths of 3 to 5 ft bgs at the site, it is expected to be shallower at those boring locations on the western side of the landfill. In that area the water table may be within 2 ft of the ground surface. The standard operating procedure for DPT sample collection is presented in Attachment 1.

During subsurface soil sample collecting, if field evidence (e.g., screening readings above ambient on a photoionization detector) indicates possible contamination, or if layers of waste are identified, one sample will be collected from that material. If there is no visual or other field evidence of waste material, a sample will be collected from a depth interval from 2 ft above the water table to the water table. If the water table is within 3 ft of land surface, a sample will be collected from a depth of 1 to 3 ft feet.

3.4.2 Surface Soil

One surface soil sample will be collected at each of the 5 subsurface soil sample locations for use in the ecological and human health risk assessment, to confirm and define the site boundaries, and to confirm that the extent of surface soil contamination is confined to the landfill surface. If a sample is determined to be outside the boundaries of the landfill it will not be used for the HHRA. Three additional surface soil samples will be collected approximately 100 ft from the landfill boundary on the north and west sides. These will also help to delineate extent. Four surface soil samples will be collected from the area between Landfill C and Landfill D in order to characterize the hydraulic dredge spoil material that predominates in the area between these two sites. The locations of the proposed additional sampling between the Landfill C and Landfill D sites are shown in Figure 3-3. All surface soil samples will be collected from depths of 0.0-6.0 inches bgs.

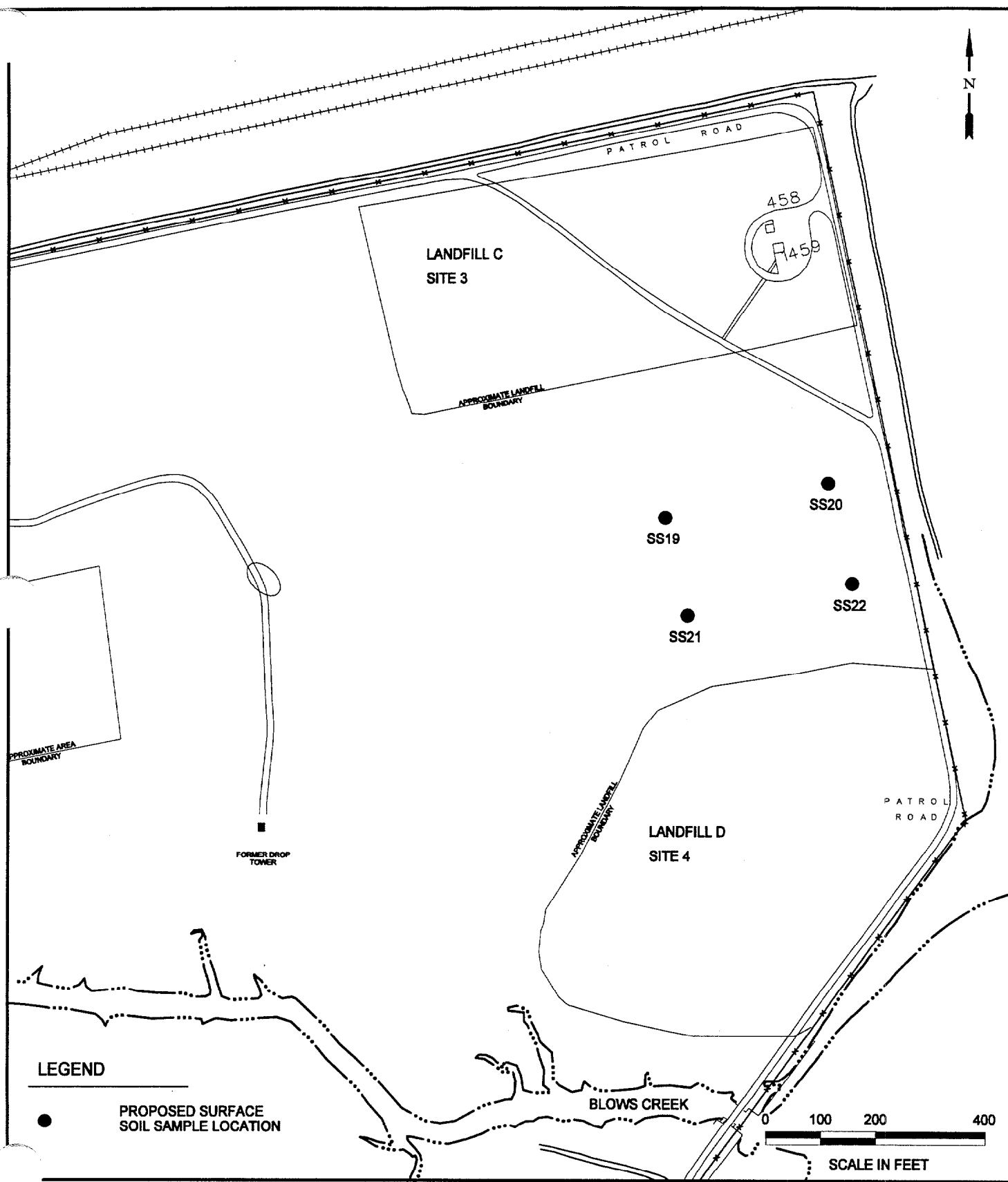
3.4.3 Groundwater

The RI investigation indicated that the six existing monitoring wells located near the perimeter of Landfill D were adequate for collecting the necessary groundwater samples. Therefore no new monitoring wells will be installed during this supplemental field investigation. However, groundwater samples will be collected from the existing wells during this investigation.

3.4.4 Surface Water and Sediment

3.4.4.1 Surface Water

During previous RI field activities at Landfill D, surface water samples from locations SW01, SW02 and SW03 could not be collected due to dry weather conditions. Therefore these surface water samples will be collected during the supplemental field



investigation if surface water is present. Additionally, surface water samples will be collected at the four new sediment sample locations described in Section 3.4.4.2.

Analysis of the surface water for salinity will be included for the ecological risk assessment. The salinity will be measured with a field instrument such as a Horiba U-10 Water Quality Meter or equivalent.

3.4.4.2 Sediment

The extent of surface water and sediment contamination in the wetland around the landfill as well as in Blows Creek was not delineated in the original RI. Therefore four additional sediment samples (and associated surface water samples) will be collected from these areas during the supplemental investigation. As shown on Figure 3-2, two samples will be located south of the landfill, one will be located north of the SD/SW04, generally to the west of the landfill, and one sample will be collected at the confluence of a small tributary and Blows Creek.

3.4.5 Sample Analyses

The proposed sampling and analysis strategy for Landfill D is summarized in Table 3-4.

3.5 Hydrogeological Investigations

3.5.1 Water Level Measurements

A full round of water level measurements will be collected during the groundwater sampling events. Water Levels in all the Yorktown Aquifer monitoring wells will be collected within a 2-hour period (or less) in order to minimize the effects of the tides.

In addition, water levels in each well will be collected at high and low tide, taking into account the estimated time lag. The time lags may be different for each aquifer.

3.5.2 Aquifer Testing

Hydraulic conductivity testing of all monitoring wells that are screened in the Water Table or Yorktown Aquifers will be conducted. Monitoring wells suspected of being screened in a perched Water Table zone will not be tested. Hydraulic conductivity will be tested using a polyvinyl chloride (PVC) slug, with data recorded on a data logger. (The standard operating procedure for the hydraulic conductivity test is presented in Attachment 1.)

The supplemental investigation will also include an investigation of tidal effects on the groundwater flow direction in both aquifers. Water levels in four Yorktown/Water Table Aquifer monitoring well pairs at the Annex will be measured over a 48-hour period using an electronic data recorder.

After well development all wells will be allowed to recover at least 12 hours prior to slug testing or the tidal study. Additionally, all wells will be allowed to recover at least 12 hours between the slug test and the tidal study. These time intervals may be

increased if experience with newly installed wells indicates that more time is needed to recover.

TABLE 3-4
LANDFILL D PROPOSED SAMPLING AND ANALYSIS STRATEGY

MEDIA/ ACTIVITY	OBJECTIVE	NUMBER OF SAMPLES	ANALYTE GROUP	SAMPLING AND ANALYSIS RATIONALE
Surface Soil	Determine extent of contamination in surface soil adjacent to the landfill. Characterize dredge spoils	12	TCL/TAL metals	Selected locations are adjacent to the landfill to the north and west (a road is to the east and Blows Creek is to the south).
Subsurface Soil	Confirm lateral extent of waste.	5	TCL/TAL metals	Located immediately adjacent to landfill on the north, south and west (borings to the east were sampled previously).
Groundwater	Additional monitoring data. No new monitoring wells will be installed.	6	TCL/TAL metals (filtered and unfiltered) Low level VOC	Collect samples from existing wells for comparison to previous sample results.
Surface Water	Refine extent of contamination in surface water. Sample locations that were previously dry during sampling event.	7	TCL/TAL metals (unfiltered) Total phosphorus Low level VOC Salinity (field measurement)	Previous surface water sample from Blows Creek was contaminated. Proposed samples will be used to further define extent. In addition, samples will be collected from drainage ditch that was dry during a previous sampling event.
Sediment	Refine the extent of contamination.	4	TCL/TAL metals Total phosphorus TOC	Locations selected to further define the sediment contamination found in a sample collected in Blows Creek during the previous sampling event. Locations are selected to be upstream and downstream of the previous sample.

ATTACHMENT 1
STANDARD OPERATING PROCEDURES
DIRECT PUSH TECHNOLOGY (DPT)

Geoprobe® Soil Sample Collection

I. Purpose

To provide a general guideline for the collection of soil samples using Geoprobe® sampling methods.

II. Scope

Standard Geoprobe® soil sampling methods.

III. Equipment and Materials

- Truck-mounted hydraulic percussion hammer.
- Geoprobe® sampling rods
- Geoprobe® sampling tubes and acetate liners (if desired)
- Pre-cleaned sample containers and stainless-steel sampling implements
- Clean latex or surgical gloves.

IV. Procedures and Guidelines

1. Decontaminate sampling tubes and other non-dedicated downhole equipment in accordance with SOP Decontamination of Personnel and Equipment.
2. Drive sampling tube to the desired sampling depth using the truck-mounted hydraulic percussion hammer. If soil above the desired depth is not to be sampled, first drive the lead rod, without a sampling tube, to the top of the desired depth.
3. Remove the rods and sampling tube from the borehole and remove the sample from the tube.
4. Fill all sample containers, beginning with the containers for VOC analysis, using a decontaminated or dedicated sampling implement.
5. Decontaminate all non-dedicated downhole equipment (rods, sampling tubes, etc.) in accordance with SOP Decontamination of Personnel and Equipment.
6. Backfill borehole at each sampling location with grout or bentonite and repair the surface with like material (bentonite, asphalt patch, concrete, etc.), as required.

V. Key Checks and Items

1. Verify that the hydraulic percussion hammer is clean and in proper working order.
2. Ensure that the Geoprobe® operator thoroughly completes the decontamination process between sampling locations.
3. Verify that the borehole made during sampling activities has been properly backfilled.

ATTACHMENT 2
STANDARD OPERATING PROCEDURES
HYDRAULIC CONDUCTIVITY TESTING

Aquifer Slug Testing

I. Purpose and Scope

The objective of this procedure is to define the requirements for conducting and analyzing in-situ hydraulic conductivity (slug) tests in small, developed wells.

II. Equipment and Materials

The following equipment should be utilized when performing a rising or falling head slug test in a monitoring well. Site specific conditions may warrant the use of additional equipment.

- Pressure transducer and data recorder, if data is to be automatically recorded, and manufacturers instructions
- Personal computer for downloading data and optionally, a field printer
- Water-level measuring device
- Stopwatch, if needed
- Slug device of known volume
- Rope or wire
- Duct tape
- Bailer
- Field Logbook
- Decontamination equipment and supplies
- Data on the construction of the well (depth to screen, screen length, well drilled diameter, riser diameter, height of sandpack above screen and length of riser above ground surface).

The slug bar may be constructed of solid plastic, such as PVC, or metal such as aluminum or steel (depending upon the chemical environment in the well). The slug bar should be of sufficient size to cause a minimum of two feet of displacement in a well. For a two-inch diameter monitoring well, the slug bar should be no more than 1.5 inches in diameter and a minimum of 5 feet long. For a four-inch diameter well, the slug bar should be no more than 3 inches in diameter and a minimum of 5 feet long. The slug bar should be securely fastened to a nylon rope or braided metal wire.

A standard sampling or well development bailer may be used in place of the slug bar, as long as the volume of water displaced by the bailer is sufficient to change the water level in the well a minimum of two feet. If the bailer is to be used for a falling head test, it should be filled with analyte-free water so that the bailer will not have any buoyancy.

III. Procedures and Guidelines

The following steps must be followed when preparing for slug testing:

1. Lay plastic sheeting around the wellhead. Arrange needed equipment and decontamination materials on the sheet.
2. Put on personnel protective clothing, as specified in the site-specific health and safety plan.
3. Open the protective casing locking lid and vented riser caps following the procedures outlined in SOP 1-6. Note the physical condition of the well, including damage, deterioration and signs of tampering. Note any unusual odors, sounds, or difficulties in opening the well. Record organic vapor readings with a suitable organic vapor screening device.
4. Measure and record the static water level, the depth to the bottom of the well and inside diameter of the well casing. Record these data in the appropriate logbook.
5. If using a pressure transducer and data logger, lower the pressure transducer into the well to a sufficient depth so that the transducer will be below the maximum depth reached by the bottom of the slug bar or other displacement device. If necessary, calibrate the transducer as specified by the manufacturer. Allow the transducer to temperature equilibrate in the well for approximately 15 minutes after insertion and prior to any calibration or test procedure to ensure that it will accurately record water level changes. Make sure that the transducer is not placed below its maximum operating depth, or it will not be able to detect any change in pressure. For example, pressure increases 1 pound per square inch (psi) per 2.3 feet of head; therefore, a 10 psi transducer will function to a depth of 23 feet below the water level in the well.
6. Secure the pressure transducer cable to the well riser or casing using duct tape. The transducer cable should lie flat along side the well riser, so that disturbance by the slug bar will be minimized. Do not kink the transducer cable, otherwise the pressure equalization vent tube in the cable will be damaged and the transducer will not function properly.
7. Allow the water level in the well to recover to static after emplacement of the pressure transducer, prior to starting the test. Measure and record this water level.
8. If using a data logger, program the data logger to record logarithmically, with a maximum time interval of no more than 1 minute between readings. If the formation is expected to have low hydraulic conductivity, the maximum interval

between readings can be set to a longer time interval, such as 10 minutes. Set the data logger to record relative change in head, not absolute head.

9. Determine the distance from the top of the well riser to the water surface in the well and add one foot to this length. The resulting length is the amount of wire or rope needed so that the slug bar or bailer will be submerged a minimum of one foot when it is placed in the well. A loop should be placed in the rope or wire at this length and a strong metal rod or wooden stick placed and secured through the loop. If the bottom of the well is less than this length added to the length of the slug bar or bailer, the length of the rope or wire should be adjusted so that the slug bar will be no less than one foot above the top of the pressure transducer when the bar is inserted into the well.
10. If depth readings are to be recorded manually (this procedure is recommended only in formations suspected of having low hydraulic conductivity, less than 5 feet per day), readings should be taken every 10 seconds for the first minute of the test, every 30 seconds for the next 4 minutes and every minute until 10 minutes. Thereafter, readings should be taken every 5 minutes for the duration of the test. If the well has not recovered within one hour, readings should be taken every 0.5 hours until six hours and one hour every hour thereafter. This process will require two personnel during the first ten minutes of the test: one to act as time keeper/data recorder and one to measure depth to water in the well.

Falling-Head Slug Test Procedure:

This test can only be conducted in wells whose screens are fully submerged, otherwise, displaced water will be introduced into the unsaturated zone and recovery rates will be due to flow in both the unsaturated and saturated zones. All slug test analytical procedures assume flow in the saturated zone only. The following steps must be followed when performing falling-head slug tests:

1. Place the slug or bailer in the well until the bottom of the displacement device is no more than 6 inches to 1 foot above the water level in the well. The person holding the device should be holding the rope or wire by the rod or stick.
2. Switch on the data recorder, or set the water level meter probe near the level at which water is expected to rise.
3. To start the test, the person holding the slug bar will signal the person operating the data logger or water level indicator, then rapidly lower the displacement device into the well until the stick or rod is resting horizontally on top of the well riser. The slug bar should not be dropped, in order to minimize sloshing in the well. The data logger is turned on or manual measurements commenced at the moment the slug bar is lowered.
4. Continue recording depth-time data until the well has recovered to at least 90 percent of the static water level. When using data recorders, it is advisable to check and record the reading every few minutes to ensure that data are being properly recorded. If 90 percent recovery has not occurred within 12 hours, the test may be stopped. Field conditions and time constraints may warrant stopping

the test in less than 12 hours. The final decisions under these circumstances will be the responsibility of the field team leader.

5. Record the time of test completion in the logbook. If a data recorder with random access memory (RAM) or erasable programmable read only memory (EPROM) was used, record the file name used.
6. Decontaminate all equipment. Clean up the site, and close and lock the well before leaving. Contaminated plastic sheeting and disposable protective clothing should be taken to designated disposal containers.
7. Download the data logger to a computer or to hard copy to ensure that the data is not inadvertently lost. If the data were recorded manually, calculate the relative change in head by subtracting the recorded depths to water during recovery from the initial static depth to water reading and record the absolute value of that change, for each depth-time data pair.

Note: Both rising- and falling-head slug tests may be carried out in the same operation by first measuring the rate of water-level fall immediately after slug insertion, then measuring the rate of water-level rise after slug withdrawal. Be sure that the well has recovered to the static water level before conducting the rising-head test. If using a data logger, the recovery tests needs to be set up and run as a separate test.

Rising-Head Slug Test Procedure:

The steps for a rising head test are essentially the same as those for a falling head test. In a well screened across the water table, a rising head test is the only test that is valid. The following steps must be followed when performing rising-head slug tests:

1. Lower the slug bar or bailer of known volume into the well until it is fully submerged. Allow the well to re-equilibrate to static water level. In formations of suspected low hydraulic conductivity, re-equilibration may take several hours or overnight. In such cases, it is suggested that the displacement device be placed in the well at the end of a field day and the test conducted the following day.
2. Turn on the data recorder, if used, or verify that static water level has been re-established with a water-level meter.
3. To start the test, the person holding the slug bar will signal the person operating the data logger or water level indicator, then rapidly and smoothly raise the displacement device from the well until the bottom of the slug bar is above the static water level in the well. The data logger is turned on or manual measurements commenced at the moment the slug bar is lowered. If a data logger is being used, the slug bar wire or rope should be secured to the well casing or riser for the duration of the test and only removed after the test has been completed, in order to avoid disturbing or dislocating the pressure transducer.

4. Continue recording depth-time data until the well has recovered to at least 90 percent of the static water level. When using data recorders, it is advisable to check and record the reading every few minutes to ensure that data are being properly recorded. If 90 percent recovery has not occurred within 12 hours, the test may be stopped. Field conditions and time constraints may warrant stopping the test in less than 12 hours. The final decisions under these circumstances will be the responsibility of the field team leader.
5. Record the time of test completion in the logbook. If a data recorder with random access memory (RAM) or erasable programmable read only memory (EPROM) was used, record the file name used.
6. Decontaminate all equipment. Clean up the site, and close and lock the well before leaving. Contaminated plastic sheeting and disposable protective clothing should be taken to designated disposal containers.
7. Download the data logger to a computer or to hard copy to ensure that the data is not inadvertently lost. If the data were recorded manually, calculate the relative change in head by subtracting the recorded depths to water during recovery from the initial static depth to water reading and record the absolute value of that change, for each depth-time data pair.

IV. Attachments

None.

V. Key Checks and Preventive Maintenance

Check the batteries for the datalogger and computer. Check that the computer disks containing the programs for the datalogger are packed. Include blank computer disks for file storage.

Check the datalogger calculation of the well hydraulic conductivity at the end of each test to determine if these are consistent with expectations.